

CLAIMS

1. A point diffraction interference measuring method comprising:

a step of forming a substantially ideal spherical wave;

a step of dividing, into two light fluxes, a light flux obtained by passing the spherical wave through a test sample;

a step of passing one light flux of the two light fluxes through a pinhole to convert the one light flux into a reference light beam which is a substantially ideal spherical wave; and

a step of detecting interference fringes generated by causing interference between the reference light beam and a measuring light beam which is the other light flux of the two light fluxes.

2. A point diffraction interference measuring method comprising:

a step of forming a substantially ideal spherical wave;

a step of dividing a light flux composed of the spherical wave into two light fluxes before passing the light flux through a test sample;

a step of passing one light flux of the two light

fluxes through a pinhole to convert the one light flux into a reference light beam which is a substantially ideal spherical wave;

a step of passing only the other light flux of the two light fluxes through the test sample to obtain a measuring light beam; and

a step of detecting interference fringes generated by causing interference between the reference light beam and the measuring light beam.

3. The point diffraction interference measuring method according to claim 2, further comprising the steps of:

using a light source and a light source pinhole in order to form the substantially ideal spherical wave; and

correcting a difference between an optical path length of the reference light beam from the light source to a section for detecting the interference fringes and an optical path length of the measuring light beam from the light source to the section for detecting the interference fringes to be within a coherent distance of a light beam coming from the light source.

4. A point diffraction interference measuring method comprising:

a step of forming a light source spherical wave which

is a substantially ideal spherical wave with a point light source-generating means;

a step of switching first measurement and second measurement, the first measurement including passing a light source light flux composed of the light source spherical wave through a test sample, thereafter dividing the light flux passed through the test sample into two light fluxes by using a first optical path-dividing element, passing one light flux of the light fluxes divided by the first optical path-dividing element through a first pinhole to convert the one light flux into a first reference light beam which is a substantially ideal spherical wave, and detecting first interference fringes generated by causing interference between the first reference light beam and a first measuring light beam which is the other light flux of the light fluxes divided by the first optical path-dividing element, and the second measurement including dividing the light source light flux into two light fluxes by using a second optical path-dividing element before passing the light source light flux through the test sample, passing one light flux of the light fluxes divided by the second optical path-dividing element through a second pinhole to convert the one light flux into a second reference light beam which is a substantially ideal spherical wave, passing only the other light flux of the light fluxes divided by the second

optical path-dividing element through the test sample to obtain a second measuring light beam, and detecting second interference fringes generated by causing interference between the second reference light beam and the second measuring light beam; and

a step of using information on the second interference fringes for alignment to be performed when the light flux, which is provided to obtain the first reference light beam of the light fluxes divided by the first optical path-dividing element, is allowed to come into the first pinhole for the first measurement.

5. The point diffraction interference measuring method according to claim 4, wherein a common pinhole is used for both of the first pinhole and the second pinhole.

6. The point diffraction interference measuring method according to claim 4, wherein each of the first optical path-dividing element and the second optical path-dividing element has a polarizing beam splitter.

7. The point diffraction interference measuring method according to claim 1 or 2, further comprising a light amount-adjusting step of adjusting at least one of a light amount of the reference light beam and a light amount of the measuring light beam so that the light amount of the

reference light beam is substantially equal to the light amount of the measuring light beam on a surface for detecting the interference fringes.

8. The point diffraction interference measuring method according to claim 4, further comprising a light amount-adjusting step of adjusting at least one of a light amount of the first reference light beam and a light amount of the first measuring light beam so that the light amount of the first reference light beam is substantially equal to the light amount of the first measuring light beam on a surface for detecting the interference fringes, and adjusting at least one of a light amount of the second reference light beam and a light amount of the second measuring light beam so that the light amount of the second reference light beam is substantially equal to the light amount of the second measuring light beam.

9. The point diffraction interference measuring method according to claim 7, wherein the light amount-adjusting step is performed by inserting a $1/2$ wavelength plate into an optical path of the light flux before dividing the light flux, and rotating the $1/2$ wavelength plate on the basis of at least one of the light amounts of the measuring light beam and the reference light beam passed through the pinhole.

10. The point diffraction interference measuring method according to claim 8, wherein the light amount-adjusting step is such a step that a first $1/2$ wavelength plate, which is arranged nearer to the point light source-generating means than the first optical path-dividing element, is rotated on the basis of at least one of the light amounts of the first measuring light beam and the first reference light beam passed through the first pinhole, and a second $1/2$ wavelength plate, which is arranged nearer to the point light source-generating means than the second optical path-dividing element, is rotated on the basis of at least one of the light amounts of the second measuring light beam and the second reference light beam passed through the second pinhole.

11. The point diffraction interference measuring method according to claim 9, wherein the light amount-adjusting step includes a measuring step of at least one of a reference light amount-measuring step of measuring the light amount of the reference light beam passed through the pinhole at a position downstream from the pinhole and a measuring light amount-measuring step of measuring the light amount of the measuring light beam after dividing the light flux, and a wavelength plate-adjusting step of rotating the $1/2$ wavelength plate on the basis of a result

of at least one of the reference light amount-measuring step and the measuring light amount-measuring step.

12. The point diffraction interference measuring method according to claim 10, wherein the light amount-adjusting step includes a measuring step of at least one of a first reference light amount-measuring step of measuring the light amount of the first reference light beam passed through the first pinhole at a position nearer to a section for detecting the interference fringes than the first pinhole and a first measuring light amount-measuring step of measuring the light amount of the first measuring light beam at a position nearer to the section for detecting the interference fringes than the first optical path-dividing element, and a first wavelength plate-adjusting step of rotating the first $1/2$ wavelength plate on the basis of a result of at least one of the first reference light amount-measuring step and the first measuring light amount-measuring step; and

a measuring step of at least one of a second reference light amount-measuring step of measuring the light amount of the second reference light beam passed through the second pinhole at a position nearer to the section for detecting the interference fringes than the second pinhole and a second measuring light amount-measuring step of measuring the light amount of the second measuring light

beam at a position nearer to the section for detecting the interference fringes than the second optical path-dividing element, and a second wavelength plate-adjusting step of rotating the second $1/2$ wavelength plate on the basis of a result of at least one of the second reference light amount-measuring step and the second measuring light amount-measuring step.

13. A point diffraction interference measuring apparatus comprising:

a point light source-generating unit which generates a spherical wave;

an optical path-dividing element which divides a light beam, which has been emitted from the point light source-generating unit and has passed through a test sample, into a measuring light beam and a reference light beam by reflection or refraction;

a pinhole which converts the reference light beam into a substantially ideal spherical wave; and

an interference fringe-detecting section which detects interference fringes generated by causing interference between the measuring light beam and the reference light beam coming from the pinhole.

14. A point diffraction interference measuring apparatus comprising:

a point light source-generating unit which generates a spherical wave;

an optical path-dividing element which divides a light beam emitted from the point light source-generating unit into a reference light beam and a measuring light beam directed toward a test sample;

a pinhole which converts the reference light beam into a substantially ideal spherical wave; and

an interference fringe-detecting section which detects interference fringes generated by causing interference between the measuring light beam coming from the test sample and the reference light beam coming from the pinhole.

15. The point diffraction interference measuring apparatus according to claim 13 or 14, further comprising a light amount-adjusting section which adjusts at least one of a light amount of the reference light beam and a light amount of the measuring light beam so that the light amount of the reference light beam passed through the pinhole is substantially equal to the light amount of the measuring light beam on a detecting surface of the interference fringe-detecting section.

16. The point diffraction interference measuring apparatus according to claim 15, wherein the light amount-

adjusting section includes a $1/2$ wavelength plate which is arranged nearer to the point light source-generating unit than the optical path-dividing element, and a rotating mechanism which rotates the $1/2$ wavelength plate on the basis of at least one of the light amounts of the measuring light beam and the reference light beam passed through the pinhole.

17. The point diffraction interference measuring apparatus according to claim 16, further comprising a reference light amount-measuring section which is arranged nearer to the interference fringe-detecting section than the pinhole and which measures the light amount of the reference light beam, and a measuring light amount-measuring section which is arranged nearer to the interference fringe-detecting section than the optical path-dividing element and which measures the light amount of the measuring light beam.

18. The point diffraction interference measuring apparatus according to claim 14, further comprising an optical path length difference-correcting section which adjusts an optical path length of the reference light beam with respect to an optical path length of the measuring light beam.

19. A point diffraction interference measuring apparatus comprising:

a point light source which generates a spherical wave;

an optical path-dividing element which divides a light beam emitted from the point light source into a reference light beam and a measuring light beam which passes through a test sample;

a pinhole which converts the reference light beam into a substantially ideal spherical wave;

an optical path-switching unit which switches an optical path for the reference light beam into a first reference optical path for making introduction into the pinhole via the test sample and a second reference optical path for making introduction into the pinhole without passing through the test sample; and

an interference fringe-detecting unit which detects interference fringes generated by causing interference between the measuring light beam and the reference light beam coming from the pinhole.

20. The point diffraction interference measuring apparatus according to claim 19, further comprising an optical path length difference-correcting section which adjusts an optical path length of the reference light beam with respect to an optical path length of the measuring light beam.

21. The point diffraction interference measuring apparatus according to claim 19, wherein the optical path-switching unit is a shutter which opens/closes the optical paths of the first reference optical path and the second reference optical path.

22. An interference measuring method for measuring an optical characteristic of a test sample placed on a measuring optical path by using an interference measuring apparatus including a point light source which generates a substantially ideal spherical wave, a dividing element which divides the spherical wave into a reference light beam and a measuring light beam which passes through the test sample, a pinhole which converts the reference light beam into an ideal spherical wave, and a detector which detects interference between the measuring light beam and the reference light beam passed through the pinhole, the interference measuring method comprising:

a first step of passing the reference light beam and the measuring light beam through the measuring optical path in a state in which the test sample is absent in the measuring optical path and adjusting the reference light beam and the measuring light beam to obtain optimum interference fringes;

a second step of placing the test sample in the

measuring optical path and changing an optical path for the reference light beam so that the reference light beam passes through the pinhole without passing through the measuring optical path;

a third step of performing alignment for the test sample relative to the measuring optical path so that a state, which is most approximate to the interference fringes obtained in the first step, is obtained after changing the optical path for the reference light beam in the second step; and

a fourth step of changing the optical path so that the reference light beam passes through the measuring optical path in a state in which the alignment has been performed in the third step to observe the interference fringes in this state.

23. A method for producing a projection lens, comprising:

measuring wavefront aberration of the projection lens in accordance with the method as defined in claim 1, 2 or 22 by using the projection lens as the test sample; and

reprocessing the projection lens on the basis of a measurement result of the measured wavefront aberration.

24. The method for producing the projection lens according to claim 23, wherein the projection lens is a

projection lens used for an exposure apparatus.